



Tracing AGN Contribution and Abundance Across Cosmic Time with JWST



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QUESTION

How does AGN contribution and AGN number fraction evolve with redshift and total IR luminosity?

BACKGROUND

- **Active galactic nuclei (AGN)** powered by accretion onto supermassive black holes; play a key role in **galaxy evolution**.
- Many **AGNs** remain undetected at UV/optical due to dust obscuration.
- Absorbed emission is re-radiated in infrared, making mid-IR observations essential for identifying obscured **AGN**.
- **JWST** provides unprecedented sensitivity and continuous mid-IR coverage, enabling robust **AGN** detection at high redshift.

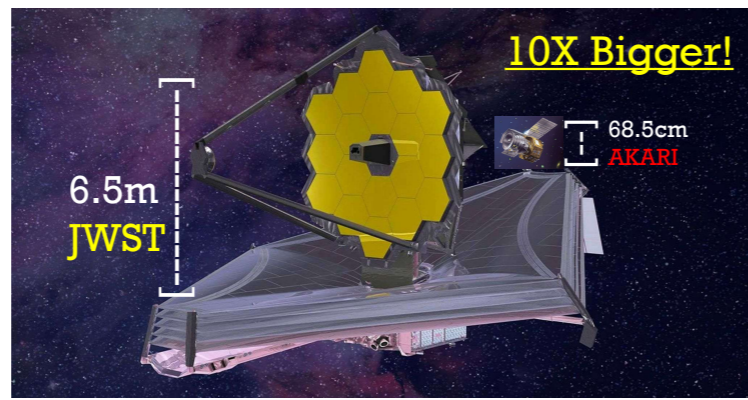
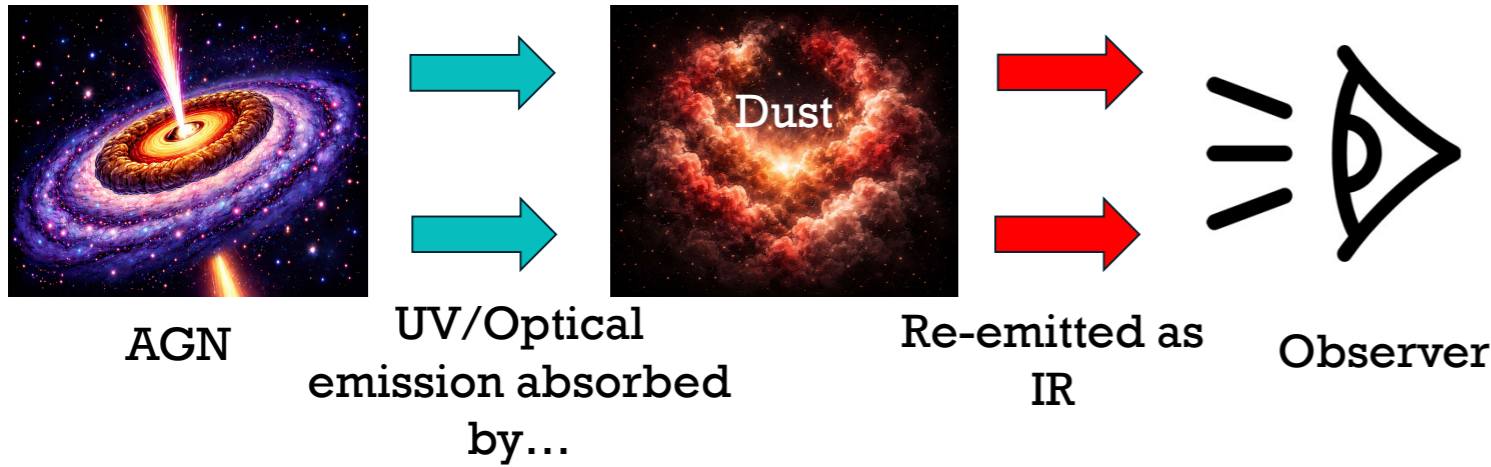


Fig 1. JWST vs AKARI mirror size comparison (Credit: JAXA, NASA)



WHY JWST SMILES?

- **Superior mid-IR sensitivity:** JWST's massive mirror (Fig 1) allows ~90x more sensitivity than AKARI/Spitzer, enabling detection of fainter and more heavily obscured AGNs.
- **Continuous 8-band MIRI coverage:** SMILES provides full 5–25 μm coverage (Fig 2), reducing SED-fitting degeneracies and improving AGN-SFG separation.
- **Larger, more complete AGN sample:** SMILES sacrifices overall FOV (34 arcmin²) for a 4x larger MIRI footprint, resulting in larger AGN sample than CEERS (100 arcmin²). We identify 290 AGNs vs 42 in CEERS (Chien et al. 2024).

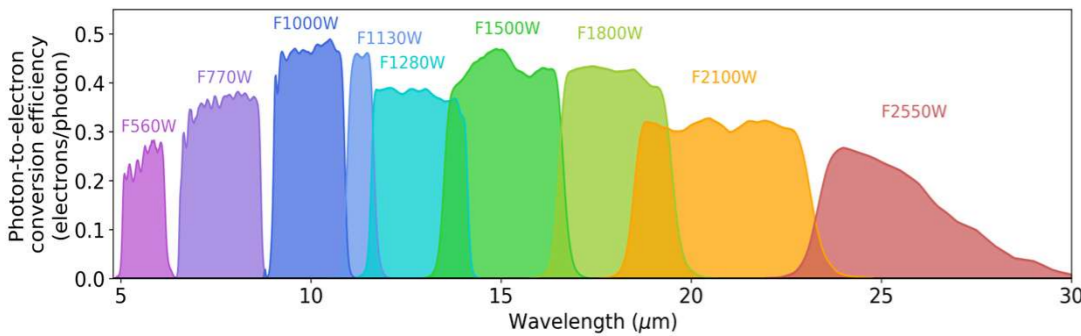


Fig 2. JWST MIRI filters (Credit: NASA)

METHODS

JWST Data

- SMILES (MIRI 5–25 μm)
- JADES (HST + NIRCam)
- GOODS-S field

SED Fitting

- Full optical–mid-IR CIGALE SED modeling
- Derived: L_{TIR} , L_{AGN} , photo-z (range: $0 < z < 10.5$)

Analysis

- AGN contribution vs. redshift & L_{TIR}
- AGN number fraction vs. redshift & L_{TIR}

AGN Identification

- AGN IR contribution ($frac_{AGN}$)
- AGN if $frac_{AGN} \geq 0.2$
- Final Sample: 2,735 galaxies (including 290 AGNs)

RESULTS

We define AGN activity as:

(a) AGN IR contribution

$$frac_{AGN} = \frac{AGN \text{ Luminosity}}{Total \text{ IR Luminosity}}$$

(b) AGN number fraction

$$f_{num} = \frac{\# \text{ of AGNs}}{\# \text{ of AGNs} + \# \text{ of SFGs}}$$

Describing the strength of AGN

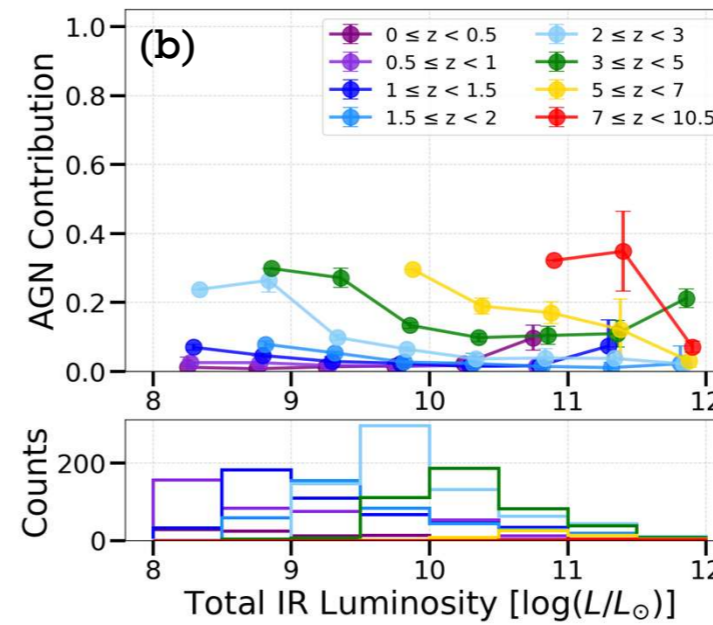
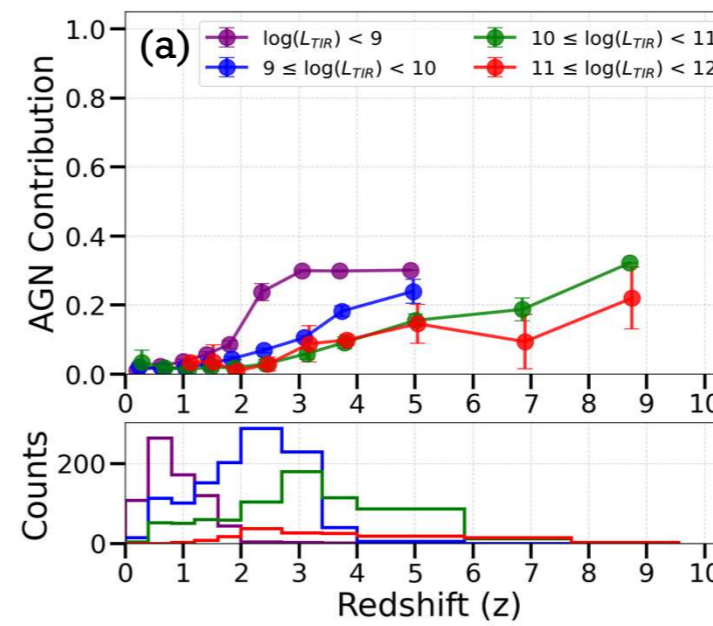


Fig 3. (a) AGN contribution vs redshift. (b) AGN contribution vs total IR luminosity.

Describing the abundance of AGN

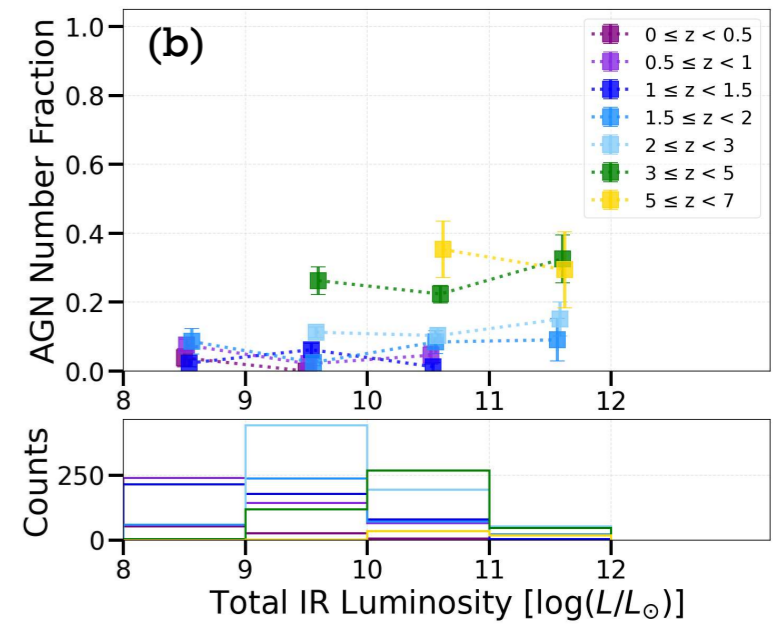
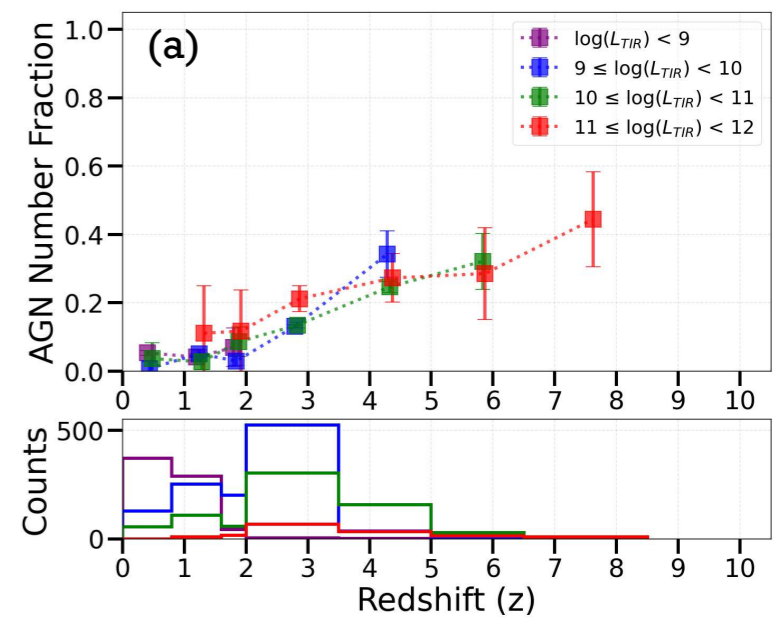


Fig 4. (a) AGN number fraction vs redshift. (b) AGN number fraction vs total IR luminosity.

DISCUSSION

- Fig 3a shows AGN contribution increases above $z \geq 2$, with the median $frac_{AGN}$ rising from 0.025 at $z \leq 2$ to a maximum of ~3.75 at higher redshift.
- In Fig 4a, the AGN number fraction similarly increases from ~3% at $z \leq 2$ to ~45% at $z \geq 2$ for low luminosity galaxies, these two observations may indicate more frequent AGN activity at earlier cosmic times.
- However, we observe in Fig 3b and 4b both AGN contribution and number fraction both decrease as a function of total infrared luminosity as especially at high redshifts ($z > 2$) and in intermediate luminosities ($9 < \log(L_{TIR}/L_{\odot}) < 12$). This may indicate where star formation dominates the IR emission.

CONCLUSION

AGN contribution and AGN number fraction **increase with redshift** and **decrease with total IR luminosity**. This may indicate that **AGN activity was more prevalent at earlier cosmic times** and **star-formation-dominates IR emission in more luminous systems**.

References

Ling et al. 2025, Santos et al. 2021, Wang et al. 2020, Chien et al. 2024,